INDOOR AIR QUALITY ASSESSMENT

Williams Middle School
200 South Street
Bridgewater, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of the Bridgewater Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA), provided assistance and consultation regarding indoor air quality concerns at the Williams Middle School (WMS) in Bridgewater, Massachusetts.

On May 10, 2002, a visit was made to this school by Cory Holmes, an Environmental Analyst in the Emergency Response/Indoor Air Quality (ER/IAQ) program, BEHA, to conduct an indoor air quality assessment. Mr. Holmes made subsequent visits on May 16th and 17th 2002. Mr. Holmes was accompanied on May 10 & 16 by Richard Flannery, WMS faculty representative of the Bridgewater Raynham Educators Association (BREA). Mr. George Mitchell, president BREA, accompanied Mr. Holmes for portions of the May 10, 2002 assessment.

The WMS is a three-story brick building constructed in 1950 (the red building). An addition was constructed in 1968 (the white building). A modular classroom wing was added in 2001. In 1997, the school underwent a number of renovations including: a new boiler plant (red building); new unit ventilators (white building); improved drainage outside the building; emergency chemical drenching showers added to science rooms; and wiring for computer network/internet capabilities. The third floor is primarily made up of science rooms and general classrooms. The second floor contains science classrooms, general classrooms, an auditorium and office space. Locker rooms, two gymnnasiums, art rooms, a wood shop, the kitchen and cafeteria, library, guidance suite and general classrooms are located on the first floor. Windows are openable throughout the building, but are difficult to operate according to occupants.

Methods

Air tests carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

This school has a student population of approximately 1,200 and a staff of approximately 110. Tests were taken during normal operations at the school and results appear in Tables 1-16.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in thirty-three of ninety-six areas surveyed, indicating inadequate ventilation in a number of areas in the school. It is also important to note, that a large number of classrooms had open windows during the assessment, which can greatly reduce carbon dioxide levels. Several classrooms (rooms 201, 205-209, 217, 305, 307, 309A, 315, 328, 329, as well as several restrooms) had elevated carbon dioxide levels with open windows and/or little to no occupancy indicating a lack of air exchange.

Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (see Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents have a manual control switch with settings of off, low, medium and high. Univents were found deactivated in classrooms throughout the school. Obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks in front of univent returns, were seen in a number of classrooms (see Picture 1). In order for univents to provide fresh air as designed, intakes must remain free of obstructions and importantly, these units must remain activated and allowed to operate while these rooms are occupied.

Exhaust ventilation in classrooms is provided by a mechanical system. The exhaust system in each classroom consists of ducted, grated wall vents in the white building and ungrated "cubby" holes in the red building, which create draw of air by rooftop motors. A number of exhaust vents in the red building were not operating or operating weakly, indicating that motors were deactivated or non-functional. BEHA staff examined exhaust motors on the roof and found several exhaust motors without belts or in the process of being repaired (see Picture 2). In addition, a number of the vents in both buildings were blocked by desks, bookcases, shelving and, in the auditorium, a row of seats (see Pictures 3 -6). As with the univents, in order to function properly, exhaust vents must be activated and remain free of obstructions.

Fresh air in the gymnasiums, locker rooms and the auditorium is provided by ceiling-mounted air handling units (AHUs). Gymnasium AHUs are usually equipped with ductwork to help distribute air throughout the gym via air diffusers. No such ductwork was installed in the WMS gymnasium. The locker room AHUs were not operating during the assessment and appeared not to have been operated for some time.

The modular classroom wing contains four classrooms. Ventilation for modular classrooms is provided by four rooftop AHUs. Fresh air is distributed to classrooms via ductwork connected to ceiling-mounted air diffusers. The amount of fresh air drawn into the units is controlled by an activator motor that adjusts the louver angle to alter fresh air intake. Return vents draw air back to the units through ceiling-mounted grilles.

Thermostats control each heating, ventilating and air conditioning (HVAC) system (see Picture 7). These thermostats have fan settings of “on” and “automatic”. Thermostats were set to the “automatic” setting in two of the four modular rooms surveyed during the assessment. The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once a preset temperature is measured by the thermostat, the HVAC system is deactivated. Therefore no mechanical ventilation is provided until the thermostat re-activates the system.

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. According to school department officials, the date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

Temperature readings were measured in a range of 68^{o} F to 79^{o} F, over the three days of the assessment, which were very close to the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range between 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. A number of temperature control/comfort complaints were expressed throughout the building. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents deactivated, exhaust vents obstructed/inoperable). While temperature readings outside the recommended range are generally not a health concern, increased temperature can affect the relative humidity in a building.

The relative humidity in this building ranged from 29 to 58 percent over the three days of testing which was below the BEHA recommended comfort range in some of the areas surveyed. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity measured indoors exceeded outdoor measurements in some areas. The increase in relative humidity can indicate that the exhaust system is not operating sufficiently to remove normal indoor air pollutants (e.g., water vapor from respiration, plumbing fixtures). The highest humidity reading was measured in the third floor boys' restroom. Exhaust ventilation was not functioning in this area (see **Other Concerns** section of this report).

Moisture removal is important since the sensation of heat conditions increases as relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As indoor temperatures rise, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. Removal of moisture from the air, however, can have some negative effects. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

The building has a history of roof leaks. A number of classrooms have water-damaged ceiling tiles and plaster, which can indicate leaks from the roof or plumbing system (see Picture 8). Active roof leaks were reported in a number of areas including rooms 200C, 203 (consumer science), 209, 327 and in the stairwell outside of room 300 where a trash barrel is stationed to catch dripping rainwater (see Picture 9). Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered.

Pooling water was observed in a number of areas on the roof (see Picture 10). The freezing and thawing of water during winter months can lead to roof leaks and subsequent water penetration into the interior of the building. Pooling water can also become stagnant, which can lead to unpleasant odors and microbial growth. In addition, stagnant pools of water can serve as a breeding ground for mosquitoes. The rubber membrane of the white building is loose and rippled due to damaged insulation beneath the membrane. School maintenance personnel have placed concrete blocks in numerous areas in order to keep the loose membrane from separating from the roof substrate (see Picture 10). School officials reported that funds have been allocated for replacement of the roof; the project was reportedly out to bid at the time of the assessment.

Exterior caulking around windows and frames was crumbling/damaged in a number of areas indicating that the water seal is no longer intact (see Pictures 11-13).

Broken windows were observed in several areas (see Tables) as well as water damaged plaster and other building materials around windows (see Pictures 14-18). The damage is most likely attributable to water penetration around window frames during rainstorms, which can lead to subsequent mold growth under certain conditions. Replacement of caulking and repairs of window leaks are necessary to prevent water penetration. Repeated water damage can result in mold colonization of window frames, curtains and items stored on or around windowsills.

Several classrooms contained a number of plants. Plant soil and drip pans can serve as a source of mold growth. Plants and potting soil were found on top of univents in several classrooms. Several plants were noted in standing water. Plants should be located away from the air stream of univents to prevent aerosolization of dirt, pollen or mold.

Signs of bird roosting and nesting materials were observed in a number of recesses (e.g. overhangs, broken block windows) around the exterior of the building (see Pictures 19 & 20). Birds can be a source of disease, and bird wastes and feathers can contain mold and mildew, which can be irritating to the respiratory system. No obvious signs of bird roosting inside the building or in ventilation components were noted by BEHA staff or reported by occupants.

Certain molds are associated with bird waste and are of concern for immune-compromised individuals. Other diseases of the respiratory tract may also result from chronic exposure to bird waste. Exposure to bird wastes is thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in either the occupational or bird raising setting. While immune-compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials.

The methods to be employed in clean up of a bird waste problem depend on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork (MDPH, 1999). Accumulation of bird wastes have required the clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this material. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine if the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989).

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the "cleaner" is required to be trained in the use of personal protective methods and equipment (to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals). In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or by the ventilation system. Methods to prevent the spread of bird waste particulates to occupied areas or into ventilation ducts must be employed. Given that containment procedures warranted are similar to those used to contain the spread of renovation-generated dusts and odors in occupied areas, the cleaner should employ the methods listed in the SMACNA Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995). A copy of an issue of the Centers for Disease Control *Morbidity and Mortality Weekly Report* for July 10, 1998, which cover the clinic aspects as well as clean up associated with bird waste, is included as Appendix II.

In several classrooms, spaces between the sink countertop and backsplash were noted. Improper drainage or sink overflow could lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly they can provide a medium for mold growth.

Active mold growth was observed on tiled walls in the shower area of the boy's locker room. The locker room showers were reportedly deactivated and the area is being used for storage. The characteristic pattern on walls and troughs directly below indicate that the deactivated showerheads are leaking (see Picture 21).

The exterior walls had spaces/cracks in brickwork. In many areas mortar around exterior brickwork appears to be crumbling or missing (see Picture 22). These conditions are breaches of the building envelope and provide a means for water entry into the building. Repeated water penetration can result in the chronic wetting of building materials and the potential for microbial growth. In addition large wall cracks may provide a means of egress for pests/rodents into the building.

Small trees and other plants were also seen growing in the tarmac/exterior wall junction (see Picture 23). The growth of roots against the exterior of foundation walls, as well as spaces between the tarmac, can bring moisture in contact with brick and foundation structures, which may eventually lead to moisture penetration below ground level areas of the building.

The modular classrooms were examined. Guidance concerning prevention of mold growth in modular classrooms suggests that the following steps can be taken to avoid microbial growth within these structures:

1. Use of sloped roof with properly installed gutter and downspout system to drain rainwater.
2. Siting the structure on a well-drained surface.
3. Surface run-off should be directed away from the structure.
4. The crawlspace under the structure should be well ventilated.
5. Check all caulking and/or flashing around windows and service posts, especially after moving a structure.
6. Maintain ventilation according to American Society for Heating, Refrigerating and Air-conditioning Engineers (Stewart, B., 2002).

Using these guidelines as evaluation points, an analysis of each modular unit was conducted:

The exterior walls of the modular units appeared to be intact and drainage adequate. A gutter/downspout system exists for the units; however one of the downspouts was missing an elbow (see Picture 24), which can allow rainwater to pool on the ground at the base of the building or against exterior walls. The freezing and thawing action of water during winter months can create cracks and fissures in the foundation. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001). There are minimal means for ventilating the crawlspace under this structure.

Other Concerns

Several other conditions that can potentially affect indoor air quality were identified. Excessive amounts of wood dust on flat surfaces was noted in the woodshop (see Picture 25). BEHA staff also noted a significant amount of wood dust in the wood shop general return vent, which indicates that sawdust is aerosolized from machinery and is entrained (drawn into) by the ventilation system. The wood shop contains a dedicated AHU. Wood dust can be irritating to the eyes, nose, throat and respiratory system. Within the AHU are heating elements. Under certain conditions, wood dust is a fire hazard.

Also noted on a tabletop were several cans of wood finisher and paint thinner. These products contain volatile organic compounds (VOCs), which evaporate readily and can be irritating to eyes, nose and throat. These products are flammable as well, and should be stored in a cabinet, which meets the criteria set forth by the National Fire Protection Association (NFPA) (NFPA, 1996).

On the morning of the May 10, 2002 visit, the exterior woodshop door was propped open, which can pressurize the woodshop under certain wind conditions, resulting in odors and dust penetrating into the adjacent areas. This door should be kept shut to prevent woodshop dusts/odors from spreading to adjacent areas of the school.

Cars parked in close proximity of the school (see Picture 26) can cause vehicle exhaust to be entrained by the mechanical ventilation system and open windows under certain weather conditions, which may, in turn, provide opportunities for exposure to combustion products such as carbon monoxide.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provide a source for dusts to accumulate. These items, (e.g., papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

The faculty workrooms have photocopiers and lamination machines. Lamination machines can produce irritating odors during use. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas. The second floor faculty work room is not equipped with local exhaust ventilation.

Accumulated chalk dust and dry erase board particulate was noted in several classrooms. Several rooms had missing and/or dislodged ceiling tiles. Missing/dislodged ceiling tiles can provide a pathway for the movement of drafts, dusts and particulate matter between rooms and floors. Chalk dust and dry erase board particulates can be easily aerosolized and serve as eye and respiratory irritants. In addition, materials such as dry erase markers and dry erase board cleaners may contain VOCs (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can also be irritating to the eyes, nose and throat.

Exposed fiberglass pipe insulation was noted in the art room, the girl's locker room, and room 101A. Airborne fiberglass particles can serve as a skin and respiratory irritants to sensitive individuals. Occupant concerns of damaged pipe insulation were expressed in classroom 210. BEHA staff also noted exposed pipe insulation in the art room storage loft, which may contain asbestos (see Picture 27). This finding was reported to WMS officials and maintenance staff upon discovery. The material was reportedly encapsulated the following morning by a licensed member of the Bridgewater Public Schools (BPS) maintenance staff. This was confirmed by BEHA staff (see Picture 28).

A number of univents had accumulated dirt, dust and debris within the air handling chambers. These conditions can be attributed to the fact that they do not run continuously, which may allow airborne particulates to settle within the units. In addition, AHUs that have been deactivated for prolonged periods of time (i.e. the locker rooms) can also have an accumulation of dust and debris. In order to avoid this equipment serving as a source of aerosolized particulates, the air handling sections of the univents and AHUs should be regularly cleaned (e.g. during regular filter changes). A number of exhaust vents in classrooms and restrooms had accumulated dust. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

Older model univents appear to be equipped with filter media that is cut to fit permanent metal racks. Frequently, cut-to-fit filter media is not installed flush in racks. Air drawn into univents will bypass filters through spaces between filters and racks. This can result in dust, dirt and other debris to be distributed by the ventilation system. AHUs in the locker rooms were equipped with filters enclosed in a vintage wire mesh/wooden frame. The material used for filter media in these metal racks provides minimal filtration of respirable particulates. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed in these units. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by the unit by increased resistance (called pressure drop). Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer to ascertain whether they can maintain function with more efficient filters. The age and function of some univents and AHUs may preclude any attempt to increase filter efficiency.

Several areas contained window-mounted air conditioners. This equipment is normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter. The unit in room 101A was missing its filter, resulting in the coils becoming coated with dust.

The consumer science room (203) contained a dryer that was ducted to the outside. BEHA staff inspected the vent and found it disconnected from the dryer. Clothing dryers are a source of lint and dusts, which can be irritating to certain individuals. Unvented dryers can also result in moisture and waste heat being vented into the classroom. Dryers should be properly vented to the outside of the building to remove lint, dusts, excess moisture and waste heat from occupied areas.

A strong chemical odor was detected in room 104. The source of the odor was a plug-in air freshener. Air fresheners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. In addition, air fresheners do not remove materials causing odors, but rather mask odors, which may be present in the area.

Strong urine odors were noted in several restrooms. As mentioned previously, mechanical exhaust ventilation in a number of restrooms was not functioning during the assessment. Exhaust ventilation is necessary in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

Conclusions/Recommendations

The conditions noted at the WMS raise a number of indoor air quality issues. The combination of the general building conditions, maintenance, design and the operation (or lack) of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

The following **short-term** measures should be considered for implementation:

1. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers throughout the school.
2. To maximize air exchange, the BEHA recommends that all ventilation systems that are operable throughout the building (e.g., gym, auditorium, classrooms) operate continuously during periods of school occupancy independent of thermostat control. To increase airflow in classrooms, set univent controls to "high".
3. Set the thermostat for modular classrooms to the fan "on" position to operate the ventilation system continuously during the school day.
4. Inspect exhaust motors and belts for proper function. Repair and replace as necessary.
5. Reactivate exhaust ventilation in restrooms to remove odors and moisture.
6. Remove all blockages from univents and exhaust vents to ensure adequate airflow. Consider relocating seats in front of auditorium return vent.
7. Once both the fresh air supply and exhaust ventilation are functioning, the systems should be balanced by a ventilation engineering firm in accordance with Standard 111, SMACNA's HVAC Systems-Testing, Adjusting and Balancing, 2nd Edition.
8. Supplement airflow in classrooms by using openable windows to control for comfort. Care should be taken to ensure windows are properly closed at night and

weekends to avoid the freezing of pipes and potential flooding. Work with staff to determine which windows are unopenable/difficult to operate and make repairs.

9. Remove bird's nests from exterior of building and install/repair bird screens as needed. To prevent possible exposure to bird wastes, implement the corrective actions recommended concerning remediation of bird wastes in Appendix II of this report. To prevent possible spread of bird waste particulates to occupied areas employ the methods listed in the SMACNA guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).

10. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

11. Replace any remaining water-stained ceiling tiles and wall plaster. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

12. Move plants away from univents in classrooms. Avoid over-watering and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.

13. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect adjacent areas for water-damage and mold/mildew

growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.

14. Replace/repair damaged downspouts and install elbows in a manner to direct rainwater away from the building.

15. Remove plant growths against the exterior wall/foundation of the building to prevent water penetration. Trim trees in rear of building away from brickwork.

16. Replace missing ceiling tiles and fill utility holes in classrooms, to prevent the egress of dirt, dust and particulate matter into classrooms.

17. Store flammables in a cabinet that meets the standards set by the National Fire Protection Association (NFPA, 1996) for storage of flammable substances.

18. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

19. Clean chalkboards and dry erase board trays regularly to avoid the build-up of particulates.

20. Ensure dryer in the consumer science area is properly vented to the outside of the building before operation.

21. Change filters for window-mounted air conditioners and air-handling equipment as per the manufacturer's instructions or more frequently if needed. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit.

22. Consider replacing metal filters in older model univents and wooden framed filters in AHUs (e.g. locker rooms) with disposable filters.
23. Clean univent return vents and exhaust vents periodically of accumulated dust.
24. Consider developing a written notification system for building occupants to report indoor air quality issues/problems. Have these concerns relayed to the maintenance department/ building management in a manner to allow for a timely remediation of the problem.
25. Consider relocating parking areas such that they are not close to the building. If not feasible, post signs instructing vehicles not to back in and to shut engines off after five minutes as required by Massachusetts General Laws 90:16A.
26. Increase cleaning of wood dust from wood shop surfaces. This can include the use of a vacuum cleaner equipped with a HEPA filter.
27. Inspect interior of woodshop AHU and ductwork for accumulated wood dust clean if necessary. Consider providing more efficient filters for woodshop return vents.
28. Refrain from using strong scented materials (e.g., air fresheners) in classrooms.

The following **long-term measures** should be considered:

1. Continue with plans for roof replacement. Once roof is repaired, replace any remaining water-stained ceiling tiles and other water damaged building materials. Examine the area above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial.

2. Examine the feasibility of enhancing drainage to areas of the roof subject to water pooling (e.g. white building perimeter, walkway). This may include redirecting the pitch of the roof towards drains or installation of new drains/downspouts.
3. Based on the age, physical deterioration and availability of parts of the HVAC system, the BEHA strongly recommends that the HVAC engineering firm fully evaluate the ventilation system for proper operation, and/or repair/replacement considerations.
4. Consider reconfiguring science classrooms to prevent blockage of exhaust vents (see Picture 4).
5. Consider having exterior brick re-pointed and waterproofed to prevent water. intrusion. Weatherproofing materials should be applied during periods when the school is not occupied.
6. Repair and/or replace thermostats and pneumatic controls as necessary to maintain control of thermal comfort. Consider contacting an HVAC engineer concerning the repair and calibration of thermostats and pneumatic controls school-wide.
7. Repair/replace loose/broken windowpanes and missing or damaged window caulking building-wide to prevent water penetration through window frames. During this project it is recommended that all water-damaged materials be examined for microbial growth and structural integrity. Repair water damaged ceilings, walls and wall-plaster as necessary.
8. Consider installing local exhaust vents in teacher’s workrooms to help reduce excess heat and odors from office equipment.

9. Examine the feasibility of installing ventilation hoods for cooking appliances in the consumer science area.

10. Examine the feasibility of installing a spray booth/drying room for application of VOC-containing materials for the woodshop and art room.

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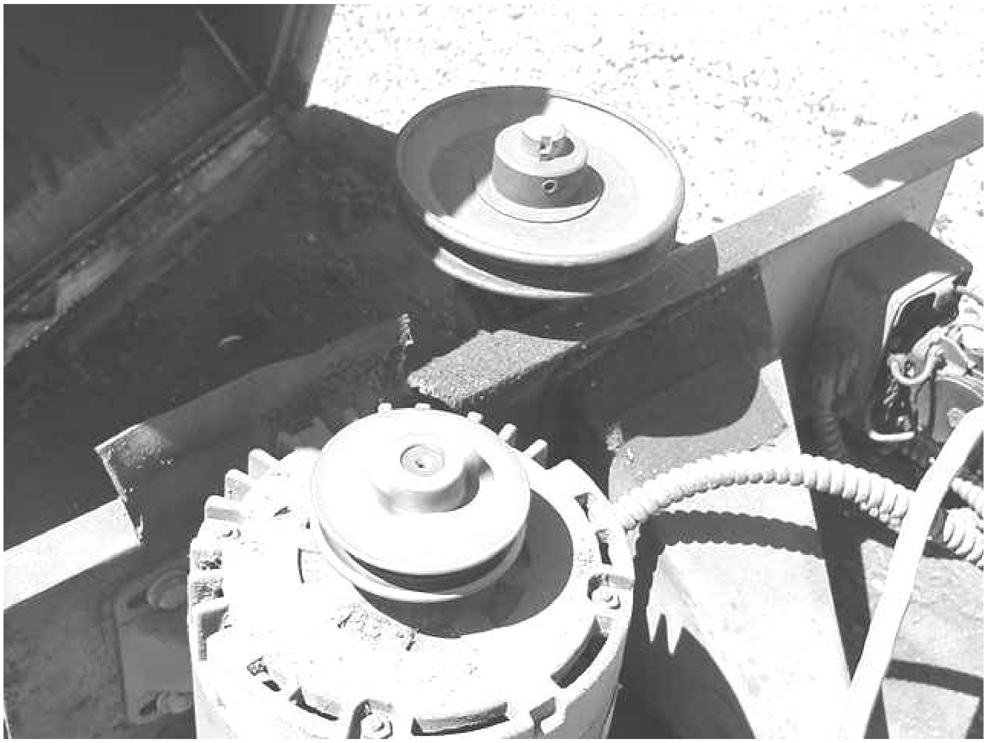
Picture 1

Univent Air Diffuser Obstructed with Drying Art Projects

Picture 2

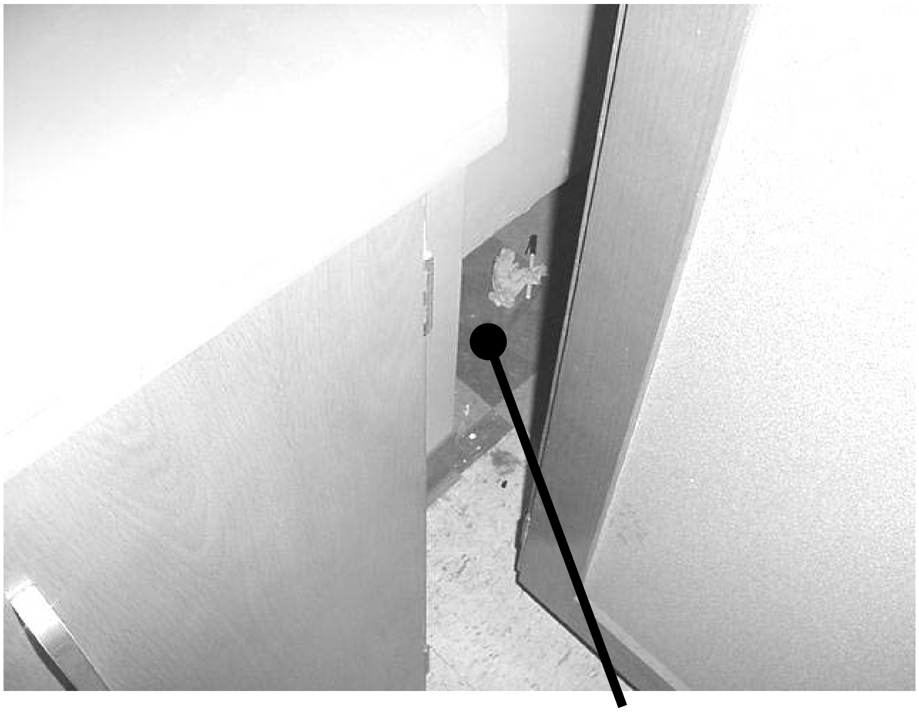


Exhaust Motor on Roof Missing Belt

Picture 3

Items in and around Exhaust Cubby Obstructing Airflow

Picture 4



Shelves in Science Classroom Built around Exhaust Cubby Obstructing Airflow

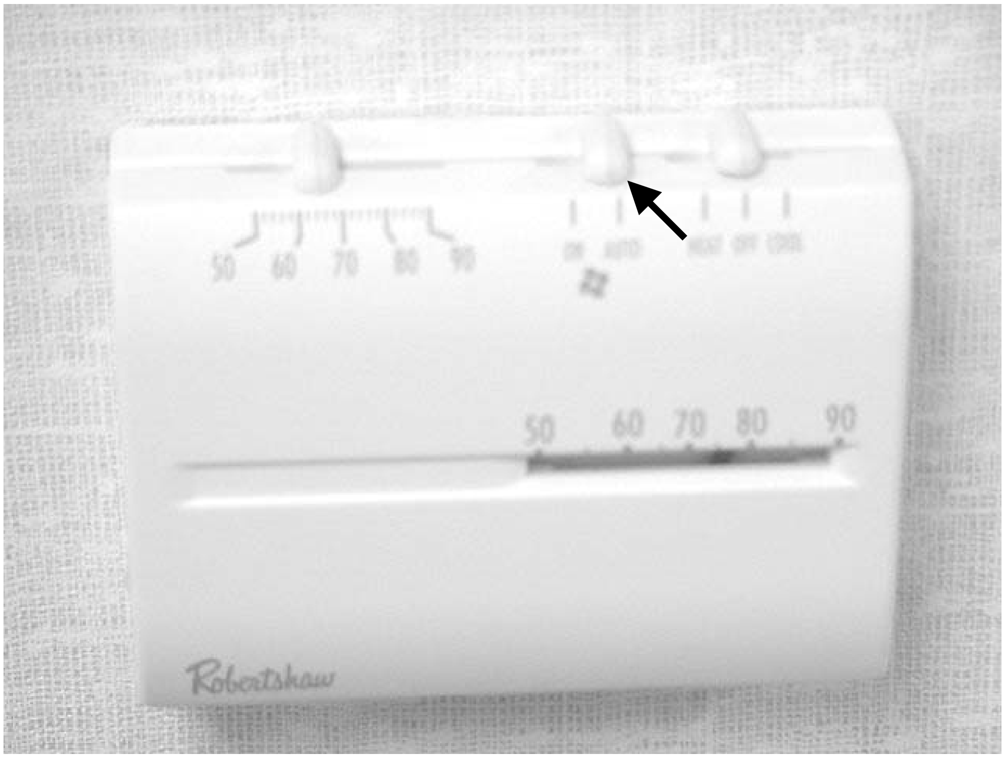
Picture 5

Classroom Exhaust Vent Blocked by Bookcase

Picture 6

Return Vent in Auditorium Obstructed by Row of Seats

Picture 7



Modular Classroom Thermostat Fan on "Auto" Setting

Picture 8

Water Damaged Ceiling Tiles, Note Tiles are of an Interlocking Design

Picture 9

Active Roof Leak in Stairwell outside Classroom 300, Note Water Damage Ceiling and Trash Barrel to Catch Rainwater

Picture 10

Standing Water and Concrete Blocks on White Building Roof

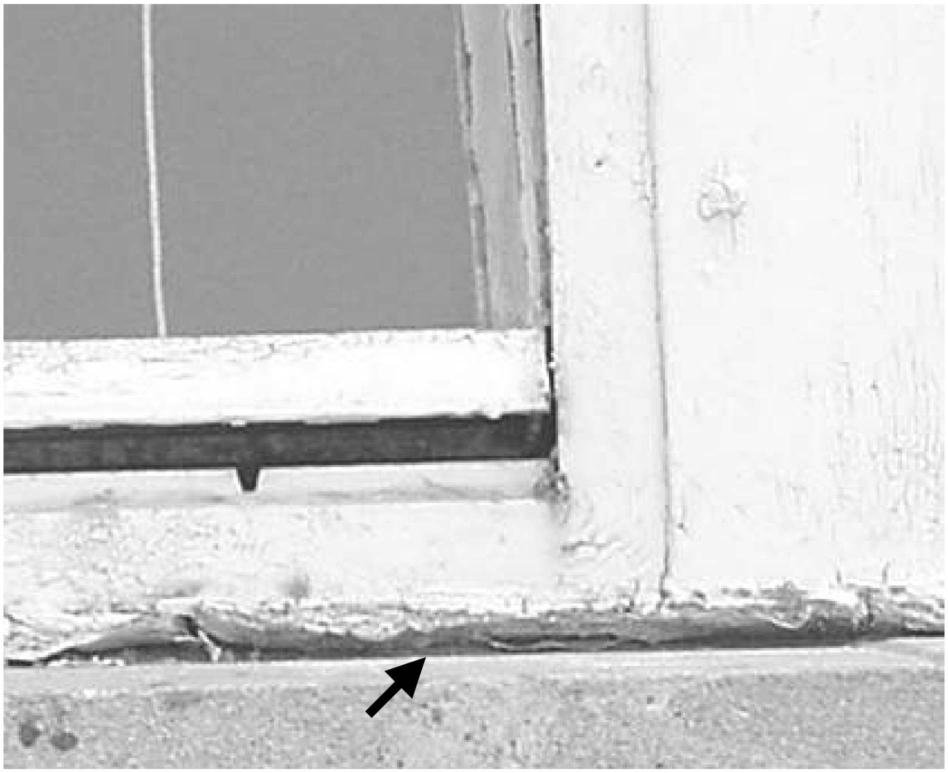
Picture 11

Missing/Damaged Window Caulking

Picture 12

Rusted Metal/Water Damaged Window Frame

Picture 13



Caulking Peeling away from Window Frame

Picture 14

Water Damaged Ceiling Tiles near Top of Window Frame in Room 203

Picture 15

Condensation between Classroom Window Panes

Picture 16

Water Damaged Plaster around Window Frame in Auditorium

Picture 17

Water Damaged Wall Plaster in Classroom 307

Picture 18

Plants on top of Univent Air Diffuser in Classroom

Picture 19

Nesting Material beneath Exterior Wall Panel

Picture 20

Gymnasium Awning White Material Indicates Accumulated Bird Wastes

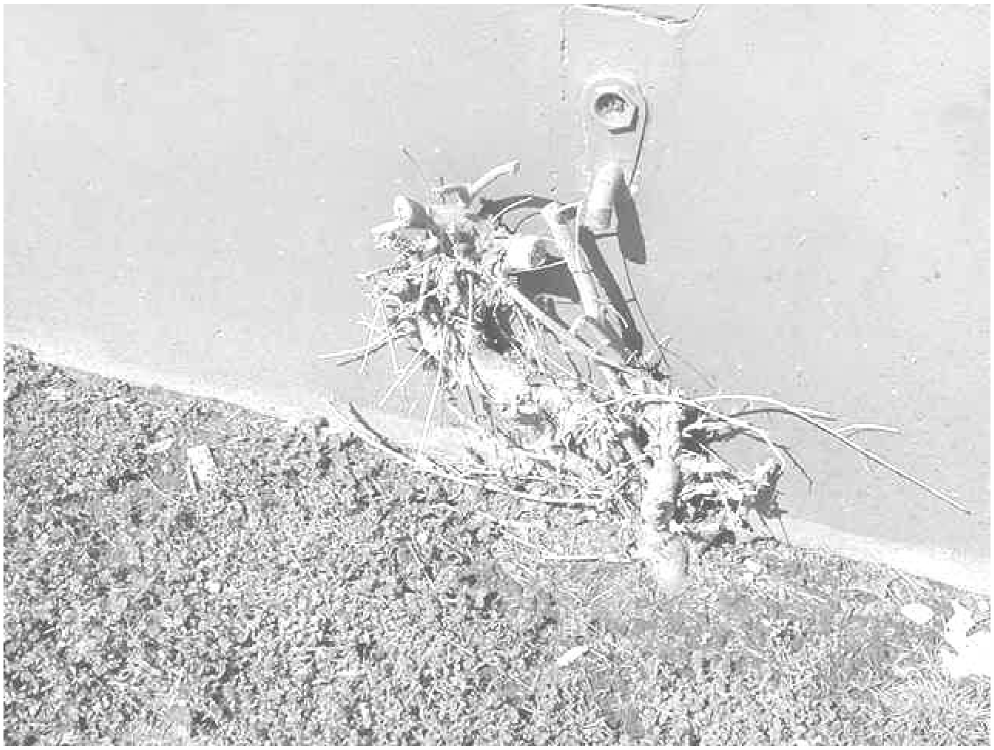
Picture 21

Mold Growth in Boy's Locker Room Shower Area

Picture 22

Missing/Damaged Mortar around Exterior Brick

Picture 23



Plant Growth against Building/Foundation

Picture 24

Missing Downspout Elbow Extension, Note Staining of Foundation

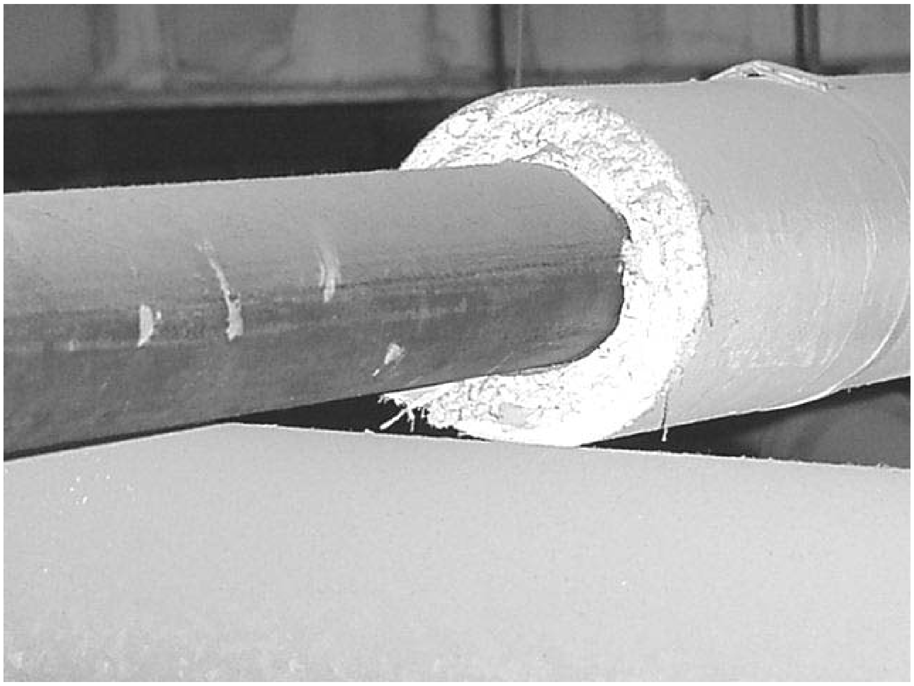
Picture 25

Accumulated Wood Dust in Woodshop, Note Machine is Connected to Dust Collector

Picture 26

Cars Backed Up Against Building (Outside Woodshop/Art Room)

Picture 27



Exposed Pipe Insulation above Art Room

Picture 28

Encapsulated Pipe Insulation Shown in Previous Picture

TABLE 1

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 10, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Outside (Background)	425	65	52					weather conditions: warm, breezy
Perimeter Notes	bee/wasp nests beneath awning aud. ent., missing/damaged-crumbling caulking outside windows, plants growth against building, subterranean pits/air intakes filled with leaves/debris, cars backed up against building, wood shop exterior door open, trees (branches) against brick, bird's nest in glass-block windows, downspouts missing elbows, missing elbow-modular, rear of gym bird/wasp							
Room 327	694	74	49	5	yes	yes	yes	2 ceiling-mounted univents – 1 reportedly does not work, chalk dust, active ceiling leak, water-damage around univent pipe, cobwebs/dust on exhaust vent, exhaust off-backdrafting, window open
Room 309A	1047	77	49	25	yes	yes	yes	window and door open-window reportedly open all night, items on univent-univent off, exhaust off/dust accumulation on vent, broken window
Room 308	730	75	44	18	yes	yes	yes	univent off, cubby exhaust-sounds on-weak-papers stuffed up inside vent, 20(+) water-damaged CTs, water-damage around window frames

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 10, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 307	1025	76	47	21	yes	yes	yes	window and door open-window broken, univent off-univent control low/med/hi deactivated, efflorescence on wall around window frames, hole in wall below window
Room 306	682	74	44	24	yes	yes	yes	window and door open, univent off-items on univent diffuser, exhaust vent blocked by cases, 4 plants
Room 305	1147	75	52	15	yes	yes	yes	window open, univent-switch on-no fan movement/airflow, items on univent, exhaust weak, broken window
Room 304	531	73	43	18	yes	yes	yes	window and door open, univent deactivated
Room 303	980	75	48	9	yes	yes	yes	window and door open, univent deactivated, exhaust blocked by desk & chair
Boy's Restroom	1203	74	58	0	yes	no	yes	strong urine odors, exhaust vents off, window sealed shut
Room 302	664	74	46	16	yes	yes	yes	univent deactivated-items in front of univent return, 2 broken windows, window open, water-damaged CTs, dry erase board

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 10, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 301	683	77	46	24	yes	yes	yes	univent deactivated, water-damaged wall plaster around windows, window open, exhaust vent (in corner) enclosed by cabinets
Room 300	647	77	43	22	yes	yes	yes	window and door open, missing CT, univent off
Stairwell								water-damaged ceiling, trash can to collect water
Chemical Storage Room								dust accumulation on vent, dislodged CT
Prep Room							yes	broken window, very little chemical storage-well kept
Girl's Restroom	745	75	40	1	yes	no	yes	dust accumulation on exhaust vents, window open
Teachers' Workroom	732	75	42	0	yes	no	no	photocopier-strong odor-no local exhaust, window difficult to open
Faculty Restroom				0	yes	yes	no	passive supply vent, no exhaust vent, with over-pressurization-will force odors out
Room 310A	695	76	40	20	yes	yes	yes	window open, fan circulating air, water-damaged CT

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 10, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 309B	1276	76	45	23	yes	yes	yes	water-damaged CTs, univent deactivated, utility hole-rear of classroom
Main Frame Room (off 309B)								computer main frame, water-damage near computer equipment, ceiling grill-could not be ID'ed – possible exhaust
Speech & Language Room	475	74	39	0	yes	no	yes	exhaust vent off-dusty, window open, 1 plant
Stairwell (auditorium)								water-damage/efflorescence on wall
Auditorium	469	71	42	0	yes	yes	yes	exhaust blocked by seats, efflorescence/water-damage on exterior wall/window frames
Custodial Office	651	71	46	0	yes	no	no	restroom exhaust vent
Room 200B	614	70	45	0	yes	no	no	restroom exhaust
Room 200C	646	71	46	2	yes	no	no	window-mounted air conditioner, active roof leaks, (local) exhaust fan sealed
Room 201	825	75	44	22	yes	no	yes	window and door open, no mechanical fresh air supply

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CT = ceiling tiles

Comfort Guidelines

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	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 10, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 203 (consumer science)	730			21	yes	yes		window and door open, active leak near window, water-damaged CT, dryer vented to outside-not connected
1st Floor Girl's Restroom	880	74	42	0	yes	yes	yes	passive supply vent, window open, exhaust off/weak, utility holes
Room 204	460	76	35	-	yes	yes	yes	window open
Room 205	1115	76	41	21	yes	yes	yes	window open, chalk dust, broken window, univent deactivated-sealed with duct tape, strong odors of occupants-stale air
Room 206	1240	77	41	21	yes	yes	yes	window and door open, exhaust off/weak, univent deactivated
Room 208	760	70	38	22	yes	yes	yes	window open, univent off-items on top, missing CT
Room 207	1216	77	40	30	yes	yes	yes	window and door open, univent off, window broken
Assistant Principal's Office	840	76	38	2	yes	no	no	window open, window-mounted air conditioner, reports of birds in air conditioner
Room 209	1280	77	41	15	yes	yes	yes	window and door open, broken windows, water-damaged CTs along window frames-current leak, univent deactivated, exhaust blocked

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 10, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 210	627	77	37	31	yes	yes	yes	window and door open, univent deactivated, water-damaged CTs
Faculty Room 2nd Floor	677	79	36	0	no	no	no	2 photocopiers - no local exhaust
Faculty – Ladies Restroom						yes	no	passive vent
2nd Floor Boy's Restroom					yes	yes	yes	passive vent, no vents near urinals
Assistant Principal's Office	653	73	32	1	yes	no	no	dislodged CT, window-mounted air conditioner
Nurse's Office	515	74	36	2	yes	no	no	window open
Main Office	876	74	41	8	yes	no	no	window-mounted air conditioner, carpet, photocopier
Principal's Office	533	77	38	1	yes	no	no	window-mounted air conditioner, window open
Roof Notes – Old Building	restroom vent motor-switch removed, motor running-no belt, large exhaust fan-very slow, exhaust motor-no belt, standing water-new building							

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 7

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 16, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Outside (Background)	416	72	28					weather conditions: clear, warm, sunshine, light breeze
Woodshop	711	75	31	19	yes	yes	yes	wood dust collection system-reintroduces air, separate HVAC, No Flammables cabinet for materials, return vent filter dirty-minimal filtration, some machinery ducted-some not, exterior door open
Art Room	781	73	34	26	yes	yes	yes	
Storage Loft								damaged/exposed pipe insulation, wood dust accumulation, damaged fiberglass insulation, HVAC cycles with thermostat
Room 101A	646	73	33	0	no	no	no	missing CT, exposed fiberglass, wall-mounted air conditioner-dirty fins/no filter, no ventilation system/windows do not open, door open
Room 101B	603	73	32	5	yes	no	no	window open, utility holes

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 8

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 16, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Faculty Lounge red building	988	68	46	3	yes	yes	yes	univent deactivated, water-damaged CT, photocopier
Cafeteria	775	70	43	~150	yes	yes	yes	windows open, all univents on
Girl's Locker Room	565	69	37	0	yes	yes	yes	ceiling AHU-deactivated-filters dirty-wooden framed, return off-dust accumulation, damaged fiberglass insulation, showers-deactivated-used for storage
Room 104	707	70	37	0	yes	yes	no	strong chemical odor, plug-in air freshener
Boy's Locker Room	753	68	41	0	no	yes	yes	showers deactivated, leaks-mold/mildew on shower walls
Gymnasium	760	69	41	0	no	yes	yes	ceiling-mounted ventilation-off, gym class outside, spaces under exterior door, numerous water-damaged CTS-beams/ceiling penetrations

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 9

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 16, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Roof Notes								loose membrane due to damaged insulation beneath, rippling, cement blocks hold it down, reported out to bid for replacement of roof/insulation/drains
Room 311	1001	78	31	28	yes	yes	yes	items on/in front of univent, exhaust partially blocked by TV cart, space between splashboard/sink, accumulated dry erase board particulate, door open
Room 312	591	77	29	26	yes	yes	yes	window and door open, univent off-table/items in front of univent
Room 313	643		31	21	yes	yes	yes	window and door open, items on univent-univent off
White 3rd Floor Boy's Restroom					no	yes	yes	5 water-damaged CTs
Room 314	749	77	32	22	yes	yes	yes	window and door open, items on/in front of univent-univent off-blocked by bookcase
Room 315	1005	77	34	22	yes	yes	yes	window and door open, exhaust blocked by bookcase, univent off-debris inside, chalk dust

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 10

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 16, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 330	727	76	31	1	no	yes	yes	return vent-no draw, chalk dust
Room 316	1045	77	36	27	yes	yes	yes	20+ computers, aquarium/terrarium
Room 317	813	77	34	27	yes	yes	yes	window open, items on univent, exhaust partially blocked
Room 318	875	77	34	28	yes	yes	yes	window and door open, exhaust vent partially blocked, potting soil/various items on univent, fan on univent with window open
Room 319	975	78	35	27	yes	yes	yes	window and door open, univent off, 11 computers, strong dry erase board odors
Room 320	780	79	36	28	yes	yes	yes	window open, univent off-desks against unit, tennis balls on chair legs
Room 329	890	77	33	0	no	yes	yes	supply-no air flow, chalk dust
Room 328	834	77	32	0	no	yes	yes	no air flow

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 11

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 16, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 321	1070	79	35	27	yes	yes	yes	window and door open, chalk dust, spaces between sink/backsplash, complaints-lack of hot water – faucet
Room 323	545	79	30	20+	yes	yes	yes	condensation on windows
Room 323	513	78	30	0*	yes	yes	yes	window open, univent off, exhaust partially blocked with items, chalk dust, *fire drill
Faculty Restroom					no	no	yes	exhaust weak, strong chemical odor, hair spray
Room 324	842	78	34	23	yes	yes	yes	condensation in windows, exhaust vent partially blocked
Walkway Roof								standing water
Room 211	511	76	31	0	yes	yes	yes	chalk dust, exhaust vent completely blocked by cabinet
Room 212	1324	78	37	25	yes	yes	yes	exhaust blocked by bag, univent off, items on univent, strong musty odor, sponge in bucket

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 12

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 16, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 213	964	78	34	21	yes	yes	yes	window open, univent off, dry erase board odors/particulate build up
Room 214	1094			26	yes	yes	yes	condensation in windows, exhaust partially blocked, items on/in front of univent
Room 215	848	77	33	25	yes	yes	yes	2 units
Room 216	653	77	33	1	yes	yes	yes	window and door open, items on univent
Room 217	1300	79	37	27	yes	yes	yes	window open, window condensation, chalk dust, check air intake
Room 218	790	79	35	25	yes	yes	yes	window open, items on univent, exhaust weak, spaces around sink
Room 219	617	78	32	21	yes	yes	yes	plants on univent-1 in standing water, univent off, exhaust vent near door, window and door open
Room 220	554	78	31	27	yes	yes	yes	univent off, exhaust blocked by open door, window and door open

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 14

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	433	70	59					weather conditions: overcast, intermittent rain, warm
White Building Office/Reception	586	73	54	0	no	yes	no	photocopier
Conference Room 2	596	73	53	1	no	yes	yes	
Faculty Restroom 1 Faculty Lounge	586	73	55	0	no	no	yes	no draw from exhaust
Faculty Restroom 2 Faculty Lounge	581	74	57	0	no	no	yes	no draw from exhaust
Faculty Lounge	528	74	54	3	yes	yes	yes	univent off, water-damaged CT near window, wall-mounted air conditioner, window open
Library	633	72	41	5	yes	yes	yes	4 wall-mounted air conditioners, 4 ceiling-mounted univents, ~50 computers, no draw of air from exhaust vent
Library Office	646	73	42	1	no	yes	yes	network equipment
Teacher's Workroom	645	74	52	1	no	yes	yes	3 photocopiers, 1 lamination machine, passive supply

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 15

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Art Room 113	1028	74	53	23	yes	yes	yes	no draw of air from exhaust, door open
Art Storage				0	no	no	yes	no draw of air from exhaust vent
Room 114	603	74	51	8	yes	yes	yes	no draw of air from exhaust vent
Room 114 Restroom					no	no	yes	
Cafeteria (white)	599	73	52	~200	yes	yes		window open, 5 univents
White Gym	518	73	51	0	no	yes	yes	4 ceiling-mounted AHUs
Boy's Locker Room	557	73	52	6	no	yes	yes	
Room 116 – Phys. Ed. Faculty	560	73	51	0	no	no	yes	exhaust vents dusty
Room 116 Restroom	574	73	49	0	no	no	yes	
Room 117	563	73	49	0	yes	no	no	
Room 117B	567	73	49	0	yes	no	no	missing CT, cardboard replacement

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 16

Indoor Air Test Results – Williams Middle School, Bridgewater, MA – May 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Modular Room 1	1055	74	55	20	yes	yes	yes	thermostat fan – "on"
Modular Room 2	1450	73	53	24	yes	yes	yes	termostat fan on cool mode
Modular Room 3	632	75	52	1	yes	yes	yes	thermostat fan – "auto" – no air flow, (24) occupants gone ~40 mins.
Modular Room 4	776	75	54	20	yes	yes	yes	window open, thermostat – "auto"/temp. control-"off", no air flow
Red Boy's Locker Room								water to showers shut off – several appear to remain wet
100A Art Room								damaged pipe insulation-repaired/sealed

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%